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A comparative analysis of environmental water quality by system of government for nations in the Organization for Economic Co-operation and Development

Curtis Powers
Iowa State University

A comparative analysis of environmental water quality by system of government for nations in the Organization for Economic Co-operation and Development

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Curtis Michael Powers

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CHAPTER 1. INTRODUCTION

Over the course of human history, people and, by extension, their governments have primarily been concerned about food, shelter, and other life essentials. Perhaps the most important concern, other than air, has been water. For good reason, too, since without it, humans would die within a few days. That, along with trade and ease of travel, may be why most major cities in the world are located near a major body of water.

As governments have formed and developed, they have faced the daunting challenge of allocating and distributing water for their peoples. One early government that met this challenge well would be the Roman Empire. When one thinks of the Empire, one might recall the elaborate system of aqueducts, many of which still stand today.

While it seems that managing water was solved a few thousand years ago by the Romans, it is still a challenge governments face today. Demand continues to rise and many countries still face issues of quality, stress, and scarcity. According to United Nations Environment Program (2007), "By 2025, water withdrawals are predicted to have risen by 50 per cent in developing countries and by 18 per cent in the developed world" (p. 6). In Figure 1 below, an International Water Management Institute study displays projected water scarcity in 2025 for most nations. Here is how they define and establish water scarcity:

> Two basic criteria of water scarcity that together comprise the overall IWMI indicator of water scarcity for countries. Using the high irrigation effectiveness scenario, these criteria are (i) the percent increase in water 'withdrawals' over the 1990 to 2025 period and (ii) water withdrawals in 2025 as a percent of the 'Annual Water Resources' (AWR) of the country. Because of their enormous populations and water use, combined with extreme variations between wet and dry regions within the countries, India and China are considered separately. The 116 remaining countries are classified into 5 groups according to these criteria (figure 1).
>
> *Group 1* consists of countries that are water-scarce by both criteria. These countries, which have 8 percent of the population of the countries studied, are mainly in West Asia and

North Africa. For countries in this group, water scarcity will be a major constraint on food production, human health, and environmental quality. Many will have to divert water from irrigation to supply their domestic and industrial needs and will need to import more food. The countries in the four remaining groups have sufficient water resources (AWR) to satisfy their 2025 requirements. However, variations in seasonal, interannual, and regional water supplies may cause underestimation of the severity of their water problems based on average and national water data. A major concern for many of these countries will be developing the large financial, technical, and managerial wherewithal needed to develop their water resources.

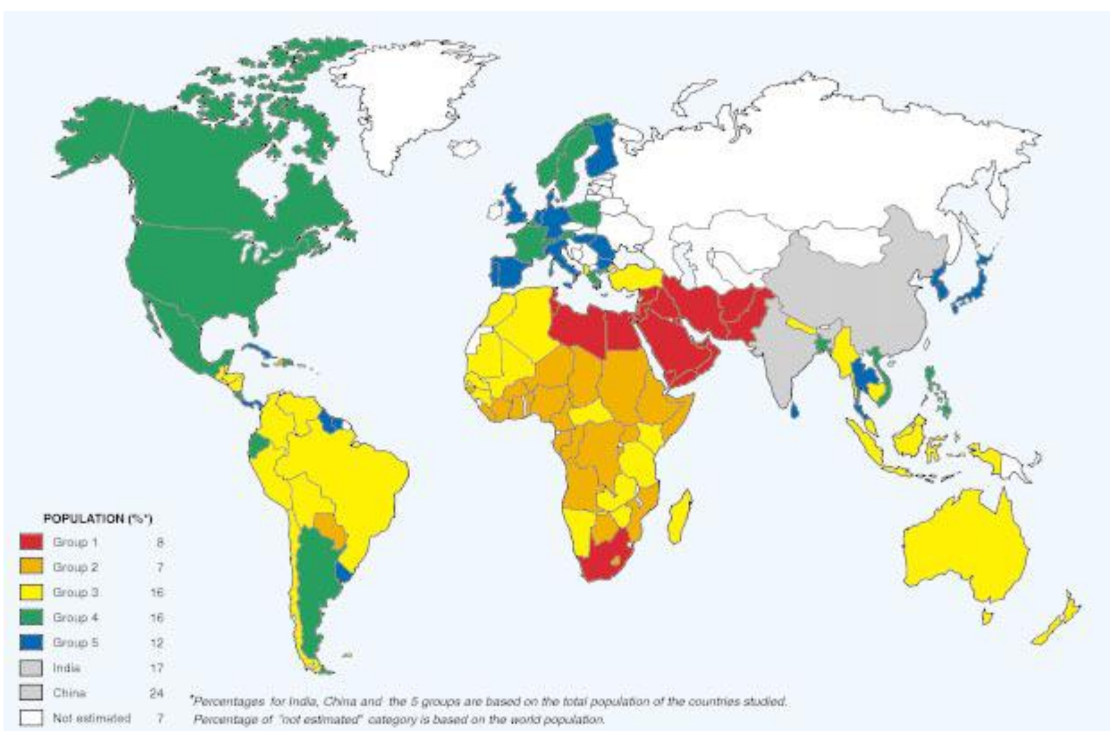
Group 2 countries, which contain 7 percent of the study population and are mainly in sub-Saharan Africa, must develop more than twice the amount of water they currently use to meet reasonable future requirements.

Group 3 countries, which contain 16 percent of the population and are scattered throughout the developing world, need to increase withdrawals by between 25 percent and 100 percent, with an average of 48 percent.

Group 4 countries, with 16 percent of the population, need to increase withdrawals, but by less than 25 percent.

Group 5 countries, with 12 percent of the population, require no additional withdrawals in 2025 and most will require even less water than in 1990 (Seckler et al., 1998, p. vi).

Figure 1. Water Scarcity Map (Seckler et al., 1998, p. vii)



There are other reasons chose to focus on the topic of water management. First, it is important because of the current debt crisis's many of the countries in the Organization for Economic Co-operation and Development (OECD) are facing. Budgets are getting cut to slash deficits. While budgets are not usually major factors in water quality outcomes, they could become a factor in this case if they lose lots of money especially for unitary states. If a unitary government is facing a debt crisis and is in control of both revenues and expenditures, tertiary areas like water may be in jeopardy. In contrast, federal states that allow sub-central governments (SCG) more fiscal autonomy may be in a better position to handle a debt crisis without sacrificing water management. While the central government may have to cut its water management budget, sub-central governments may be in position to fill in the gap with both funding and management.

Second, water is an important area of policy that affects everyone. As Figure 1 above shows, most OECD countries are not facing water problems. Is that due to governance, prosperity, natural geography, etc.? What lessons can be applied for other OECD countries or countries in the developing world?

Third, Rodden (2004) notes that in the past, "Distinctions between various shades of decentralization and federalism have not been taken seriously. Questions about the design, content, and form of decentralization are glossed over, not because the theories and hypotheses of interest are undifferentiated but because more refined data are difficult to collect" (p. 482). The major point in his article is that most decentralization studies have relied upon data that does not accurately reflect reality (i.e., sub-central government expenditures).

Lastly, research is also somewhat lacking. As Rodden (2004) states, "The basic structure of governance is being transformed in countries around the world as authority and resources migrate from central to subnational governments. Political scientists and economists have developed a wealth of theories to explain the causes and consequences of these shifts, but systematic empirical testing has lagged behind" (p. 481).

So this paper will try to fill in a research gap by focusing on water management by system of government in OECD nations. System of government, according to Braun (2000), focuses on the question: is the power to act and the power to decide policy vested in a central government (unitary) or divested to local governments (federal) or somewhere in between? OECD nations were chosen because there was available data on them, although not all OECD nations were included in this study. Some were left out because they were admitted after the data set used for testing was created (Chile, Estonia, Israel, and Slovenia). Others were left out because the data set used did not have data available for them (Hungary, Ireland, Luxembourg, New Zealand, Slovakia, and the United States). It is unclear why they were left out.

But before compiling and using data to answer questions about the relationship between federalism and water, it is worth reviewing what previous studies on the topic have found.

CHAPTER 2. LITERATURE REVIEW

This literature review will focus on the impact of federalism on water quality. Braun (2000) provides a macro-level evaluation while Heikkila (2004) provides a micro-level example.

Braun (2000) does not think the system of government, as measured by the degree of centralization, matters for water quality. In Chapter One of the book he edited, a chapter that is essentially a literature review, he writes, “Lane and Ersson find a clear relationship between the territorial division of power and policy output or outcome only with regard to the budget structure of states: unitary states have a more centralized budget structure while federal states adhere to a more decentralized one” (Braun, 2000, p. 2). While a budget determines how much money goes towards water management and is important, it does not seem to be a major factor in water quality outcomes.

Furthermore, he writes, “There are a number of structural developments that point to the fact that the demarcation between federal and unitary states is becoming less rigid above all because of the process of regionalization in most European states that has strengthened the meso-level of territorial power.… In general, success and failure of national governments in unitary states depend on the cooperation of sub-governments in very much the same way as they do in federal states” (Braun, 2000, p. 3).

Heikkila (2004) examined California’s water management programs. She found that institutions have gotten better at managing water, but problems like governance and scale still exist especially as more jurisdictional boundaries are crossed. Overall though, her paper agreed with Braun. As she stated, “These results suggest that policymakers may need to use existing institutions or create new ones in order to control the boundaries of the resource when seeking to devise effective resource management programs. Yet, this study reminds policymakers that institutional control over the resource does not require the development of a single jurisdiction that overlies resource boundaries" (Heikkila, 2004, p. 112). In terms of this study, it indicates that federal states and other states that allow for local control and coordination may not be at a disadvantage compared to highly centralized states in water quality outcomes.

CHAPTER 3. DATA AND METHODS

To analyze and test how different systems of government perform at managing water issues, there needs to be a system for grouping the structure of government institutions and an index by which to measure performance.

The index chosen to measure performance was the Environmental Performance Index, which was put together by many researchers, most notably ones from the Yale Center for Environmental Law & Policy and the Center for International Earth Science Information Network at Columbia University. As is stated in their main report, “The 2010 Environmental Performance Index (EPI) ranks 163 countries on 25 performance indicators tracked across ten policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to established environmental policy goals” (Emerson et al., 2010, p. 6).

As for the actual focus on environmental water quality, this indicator is focused on the following, “Water issues are, by nature, interdisciplinary and multi-faceted. No single index can provide comprehensive information about water availability, use, quality, and access. The 2010 EPI contains three indicators that measure water quality, water stress (a measurement of areas within the country where water resources are oversubscribed), and water scarcity (a national level measure of water use divided by available water)” (Emerson et al., 2010, p. 42).

Next, there needs to be a variable to measure federalism. Blöchliger and King (2006) probably have developed the closest measure to date focusing on fiscal autonomy of sub-central governments. “Fiscal autonomy of sub-central governments is multi-faceted and must be assessed using several indicators… Together, the table comprises six indicators capturing fiscal autonomy from different angles. The seventh indicator, 'share of autonomous SCG tax revenue,' is the product of the sub-central tax revenue share and the autonomy over those taxes; this product comes closest to what one could call a composite indicator of fiscal autonomy" (Blöchliger and King, 2006, p. 179). Fiscal autonomy for sub-central governments is a good measure of centralization, since Braun (2000) makes the case that the main difference between systems of government is based upon fiscal matters. Fiscal autonomy in this study refers to the autonomous SCG tax revenue indicator from Blöchliger and King which is a much better variable than ones like SCG expenditures because it accounts for both share of revenue and how much control it has of the revenue. It should be noted that Braun wrote in 2000 before Rodden as well as Blöchliger and King. That means he may have been working with less than reliable literature and data.

This paper also gathered information on a number of variables that might impact both a country's water score and its system of government. These variables include: water withdrawal divided by renewable water and water withdrawal - % from agriculture. The information for the water withdrawal categories was gathered from the Central Intelligence Agency Factbook (2011).

The variable, water withdrawal divided by renewable water, was chosen because it shows how much water is withdrawn with regard to the amount of renewable water sources available. It might be difficult to have a good water score if renewable water sources are heavily used by the country since this seems to be how water stress score is determined. Furthermore, this variable could affect the system of government. Central governments may be more tempted to intervene and centralize power if renewable water sources are stressed, which would weaken federalism.

Water withdrawal - % agriculture was chosen because it could affect the water quality score as scored by the EPI as well as the system of government. As for its potential effect on water quality score, Emerson et al. (2010) state, "Water Quality Index (WQI) uses three parameters measuring nutrient levels (Dissolved Oxygen, Total Nitrogen, and Total Phosphorus) and two parameters measuring water chemistry (pH and Conductivity). These parameters were selected because they cover issues of global relevance (eutrophication, nutrient pollution, acidification, and salinization) and because they are the most consistently reported… Increases in nitrogen and/or phosphorus in natural waters, which result largely from agricultural runoff and synthetic fertilizers or from municipal and industrial wastewater discharge, can result in significant water quality problems, including harmful algal blooms, hypoxia and declines in wildlife and wildlife habitat. Excesses have also been linked to higher amounts of chemicals that that are harmful for humans" (p. 42). Since the negative effects described above occur downstream and away from farmers, central governments would likely need to act to coordinate policy, probably resulting in weakening federalism.

Next, data from the Excel spreadsheets will be displayed. The table shown will have the countries listed in order of performance as measured by the total column as shown below in Table 1. It includes the EPI numbers for water quality, water stress, water scarcity, and total. It should be noted that water quality is weighted twice as much as both water stress and water scarcity by the EPI. It also includes the other variables used for testing: tax autonomy, water withdrawal divided by renewable water, and water withdrawal - % from agriculture.

Table 1. Country Data

Country	Water Quality	Water Stress	Water Scarcity	Total	Tax Autonomy	WW/ Renewable Water	WW-Agriculture
Austria	95.1	100.0	100.0	97.6	1.4	4.4	1.0
Norway	95.1	100.0	100.0	97.6	12.9	0.6	10.0
Sweden	96.2	92.8	100.0	96.3	32.1	1.5	9.0
Iceland	100.0	84.3	100.0	96.1	23	0.1	0.0
Switzerland	86.9	100.0	100.0	93.5	40.6	4.7	2.0
Finland	87.6	91.6	100.0	91.7	19.3	2.1	3.0
Canada	93.1	76.7	100.0	90.7	41.5	1.3	12.0
Japan	87.8	54.9	100.0	82.6	20.8	20.6	62.0
Denmark	74.9	71.8	100.0	80.4	32.3	11.0	42.0
France	86.5	46.6	100.0	79.9	8.1	17.5	10.0
Czech Republic	74.5	69.7	100.0	79.7	1.2	11.9	2.0
Poland	81.6	55.1	100.0	79.6	4.1	18.6	8.0
Greece	77.1	59.6	100.0	78.5	0.6	12.1	81.0
South Korea	84.9	43.4	100.0	78.3	12.1	26.7	48.0
United Kingdom	81.6	46.6	100.0	77.5	4.5	7.3	3.0
Portugal	77.9	42.9	100.0	74.7	2.6	15.1	78.0
Italy	82.2	30.2	100.0	73.7	10.6	24.0	45.0
Germany	78.6	32.5	100.0	72.4	4.1	20.2	20.0
Spain	83.1	13.2	100.0	69.9	17.6	33.5	68.0
Netherlands	73.2	23.1	100.0	67.4	3.6	9.9	34.0
Turkey	57.9	35.6	100.0	62.9	0	17.0	74.0
Mexico	61.4	17.0	100.0	60.0	3.4	17.1	77.0
Australia	61.7	8.3	100.0	57.9	18.5	6.0	75.0
Belgium	66.3	6.3	87.2	56.5	19.4	35.8	1.0

A multiple regression model was estimated using Microsoft Excel to obtain the results using a 95% confidence level.

CHAPTER 4. RESULTS AND DISCUSSION

For hypothesis testing and model estimation, the total water score based upon water quality and water stress is the dependent variable. The estimated model will be used to determine whether or not a system of government plays a factor in water quality outcomes, controlling for other relevant predictor variables. Based upon the system of government literature, the degree of government centralization should not affect the water outcome. However, it may be correct due to deficient data and testing.

Total Water Score:

H_0: System of government is not related to the total water quality score.

H_A: System of government is related to the total water quality score.

Listed below in Tables 2, 3, 4, and 5 are the regression statistics, variance inflation factor, analysis of variance table, and the model parameter estimates together with standard errors, *t*-tests, and *p*-values.

Table 2. Regression Statistics

Regression Statistics	
Multiple R	0.766
R Square	0.587
Adjusted R Square	0.525
Standard Error	8.728
Observations	24

The R square value indicates that 58.7% of the variance in total water score can be explained by this model. The adjusted R square value of 52.5% is only slightly lower, indicating that the model is relatively free of multicollinearity.

Furthermore, a variance inflation factor (VIF) was measured to check for multicollinearity as well to provide more confidence in the model. If a variable's VIF is greater than five, it indicates a high degree of multicollinearity. The VIFs for each variable concurred with regression statistics found in Table 3 above. They are shown below in the bottom half of Table 4 and are bolded. The top half of the table is a table of correlations which was used to help conduct the VIF test. It may look like some of the variables overlap in what they measure, but as the VIF shows, they are different.

Table 3. Correlation and VIF Results

	Total	*Tax Autonomy*	*WW/ Renewable Water*	*WW- Agriculture*
Total	1.00	0.41	-0.64	-0.60
Tax Autonomy	0.41	1.00	-0.28	-0.27
WW/ Renewable Water	0.64	-0.28	1.00	0.36
WW- Agriculture	0.60	-0.27	0.36	1.00
Total	**3.34**	-1.24	1.86	0.76
Tax Autonomy	1.24	**2.27**	-0.91	-0.09
WW/ Renewable Water	1.86	-0.91	**2.57**	0.18
WW- Agriculture	0.76	-0.09	0.18	**1.93**

Table 4. ANOVA Table

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2165.284	721.761	9.474	0.0004
Residual	20	1523.609	76.180		
Total	23	3688.893			

Table 5. Regression Results

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	89.333	4.391	20.346	**<0.001**
Tax Autonomy	0.162	0.152	1.070	0.297
WW/ Renewable Water	-0.597	0.196	-3.056	**0.006**
WW- Agriculture	-0.147	0.064	-2.293	**0.033**

Based upon the *p*-value for tax autonomy, we fail to reject the null hypothesis. System of government does not play a factor in water outcomes in this model. At 95% confidence, the intercept and variables, water withdrawal divided by renewable water and water withdrawal- % from agriculture, do play a factor in the total water quality scores. For this model and its assumptions, that means that every country starts at a water score of 89.333 based upon the intercept. Then, the scores fall by 0.597 for every percentage point of WW/ Renewable Water. So the more water withdrawn, the worse a country's score is. It also gets worse if a country uses more water for agriculture. Its water score will then fall by .147 point for every percentage point of water withdrawn for agriculture. Other models were tried and tested, but they did not change the coefficients too much or help eliminate the variability as measured by R squared and adjusted R squared. For example, variables like desert, GDP/capita, population density, government expenditures/GDP, length of waterways, the Gini index, good governance score, and others were added and subtracted with little to no improvement.

CHAPTER 5. CONCLUSION

The results indicate that the literature on federalism seems to be correct with regards to water management. The degree of centralization is not a statistically significant predictor of water quality score in this model. The intercept and variables, water withdrawal divided by total renewable water and desert, are significant predictors, which is not too surprising. They are directly tied in with water issues. However, the R square value indicates that the model leaves some of this variability unexplained. Future research on governance in other areas of policy and management would need to be done to confirm the results of this study.

REFERENCES

Blöchliger H. and D. King. (2006). Less than you thought: The fiscal autonomy of sub-central governments, *OECD Economic Studies*, *43*. Retrieved (11/27/11) from http://www.oecd.org/dataoecd/62/59/40507581.pdf

Braun, Dietmar. (2000). *Public policy and federalism*. D. Braun (Ed.). Burlington, NH: Ashgate.

Central Intelligence Agency. (2011). *The world factbook*. Retrieved (11/27/11) from https://www.cia.gov/library/publications/the-world-factbook/

Emerson, J., D. C. Esty, M.A. Levy, C.H. Kim, V. Mara, A. de Sherbinin, and T. Srebotnjak. (2010). *2010 Environmental Performance Index*. New Haven: Yale Center for Environmental Law and Policy. Retrieved (11/27/11) from http://epi.yale.edu/file_columns/0000/0157/epi2010_report.pdf

Heikkila, Tanya. (2004). Institutional boundaries and common-pool resource management: A comparative analysis of water management programs in California. *Journal of Policy Analysis and Management*, *23*(1), 97-117. Retrieved (11/27/11) from http://www.jstor.org/stable/3326193

Rodden, J. (2004). Comparative federalism and decentralization: On meaning and measurement, *Comparative Politics*, *36*, 481-500. Retrieved (11/27/11) from http://www.jstor.org/stable/info/4150172

Seckler, D., U. Amarasinghe, M. David, R. de Silva, and R. Barker. (1998). *World water demand and supply, 1990 to 2025: Scenarios and issues*. Retrieved (11/27/11) from http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/PUB019/REPORT19.PDF

United Nations Environment Program. (2007). *Global environment outlook 4 media brief*. Retrieved (11/27/11) from http://www.unep.org/geo/GEO4/media/media_briefs/Media_Briefs_GEO-4 Global.pdf